Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Revision of the Commission's Rules	)	CC Docket No. 94-102
To Ensure Compatibility with	)	
Enhanced 911 Emergency Calling Systems	)	
	)	
Wireless E-911 Phase II Automatic	)	DA 99-1049
Location Identification Requirements	)	

To: The Chief, Wireless Telecommunications Bureau

COMMENTS OF OMNIPOINT TECHNOLOGIES, INC.

Omnipoint Technologies, Inc. ("OTI") herein submits its comments in response to the Commission's Public Notice on Location Identification Requirements[1]. OTI recognizes and appreciates the Commission's ongoing efforts to promote the rapid implementation of wireless E911 capability. Clearly, the public interest is best served by the timely resolution of the many complex issues now before the Commission and OTI submits its comments in support of this process.

EXECUTIVE SUMMARY

The purpose of this contribution is several-fold. First, it provides comments for consideration by the Federal Communications Commission ("FCC") regarding modifications to the current ALI accuracy requirement. Second, it provides a critique of various Automatic Location Information ("ALI") accuracy metrics that are either in use or proposed. Third, it recommends language for incorporation into an updated accuracy requirement. This language not only clarifies what is meant by ALI accuracy but also assures that this accuracy metric can be used in the evaluation of all location measurements independent of the vendor and location technology chosen.

[1] Public Notice, *Wireless Telecommunications Bureau Requests Targeted Comment on Wireless E911 Phase II Automatic Location Identification Requirements*, DA 99-1049 (released June 1, 1999).

The following language regarding ALI accuracy is recommended:

> All Phase II E911 calls shall be located with accuracy defined by a circle of radius 125 meters with a Circular Error Probability[2] ("CEP") greater than or equal to 0.67. This CEP will be an average of several conditional CEP's that are also defined by circular regions of radius 125 meters centered on the user's true position. The set of user true positions hypothesized are to be uniformly located throughout the deployment region to be defined."

In addition to ALI accuracy, integrity and system reliability are important location system performance metrics needing characterization in order to evaluate and to validate the performance capability of an operational location system. Both performance metrics are discussed from the perspectives of system performance evaluation and validation. Location integrity refers to the ability of the system to provide timely warnings to users when the system should not be used, i.e., it serves to minimize "system lies." In summary, integrity is concerned mainly with user safety while system reliability is concerned with safety and expediency of operation.

For purposes of system performance evaluation and validation, it is also recommended that language be included in the updated mandate in support of specifying the metrics of integrity and system reliability. Together with the ALI accuracy requirement, these additional requirements will serve to provide a common basis for performing acceptance tests prior to the systems operational use and delivery; they will also serve to maximize user safety.

A. Perspective

From the perspective of ALI accuracy, OTI believes that the current accuracy statement mandated by the FCC is not adequate because there is no specified confidence level associated with the ALI accuracy requirement. Furthermore, the RMS methodology is not standardized nor well defined and, as stated, OTI believes it oversimplifies and inadequately specifies ALI accuracy requirements. Therefore, modification of the existing FCC accuracy requirement is suggested and a recommendation for this statement is provided below.

Further, the FCC regulation is also incomplete from the perspectives of quantifying the notions of system integrity and reliability. Since safety and expediency are both involved in the implications of these performance validation metrics, it is recommended that

[2] Historically speaking, it should be noted that the term "Circular Error Probability" is used to characterize the probability that the measurement falls outside a circle of radius r, the target being located at the center of the circle. In this sense, the probability of measurements falling inside a circle of radius r should be referred as the "Circular Correct Probability ("CCP")." This implies the target is hit. In what follows, the term CEP will be used to be consistent with the language used in earlier filings.

additional language be crafted in the regulation to cover the evaluation/validation of the system performance from these perspectives.

B. Validity of the X%RMS Accuracy Criteria

The X%RMS accuracy criteria is defined to be the RMS value of the residual population of measured latitude/longitude data points after 100 – X% of the "bad data points" are subjectively removed from the universe of measured data points. By subjective is meant that the decision criteria of what characterizes this set of points will likely vary from person to person. These so-called "bad data points" are called outliers in the population of measured points. When these "bad data points" are included in determining the RMS value of the accuracy, they render a much larger RMS value than the true RMS value of the underlying distribution.

Currently, several vendors who perform field measurements use this approach to characterize the accuracy of their field measurement results. In any valid probability experiment, all measurement data collected must be used in assessing the probability of events associated with the field of events. When certain "bad data points" (called outliers) are arbitrarily alleviated from the 'universe' of sample points, one has not considered a valid probability experiment (one can only collect a finite number of samples) and the axioms of probability do not apply. Any accuracy statement made in this probability context is ambiguous with regard to system accuracy performance evaluation and validation.

In this regard, OTI does not believe in the use of a location performance metric that subjectively eliminates a subset of the location error-measurement data (probability mass). Rather, when such an approach is adopted a decision criteria should be defined and applied consistently within the location system itself to the timely removal of such points. Otherwise, such "bad data points" or "system lies" persist from the perspective of the end user (e.g. a PSAP or 911 caller) and system integrity suffers.

As discussed further below, such outliers should be dealt with through the use of a measurement quality metric in the Mobile Location Center ("MLC"). Usually the outliers are associated with "system lies" and as such should be dealt with via an accuracy integrity metric. For example, if the radius of the cell is 500m and the latitude/longitude measurement indicate the user is 1500 meters away from the serving base station, then this measurement should not be accepted in the error measurement statistics nor reported to the Public Safety Answering Point ("PSAP"). An MLC algorithm designed with measurement integrity in mind will not allow such measurements to be announced ("lies" told to the PSAP and the user). Hence, these measurements are not a part of the error statistics that will be used in assessing ALI performance accuracy; and therefore, the measurement population collected in this way can be used to model the joint statistics of the user's true position.

C. Comments on the WEIAD Recommendation

On November 25, 1998 WEIAD submitted the following recommendation[3]:

> "Phase II location will be attempted on all calls routed toward a Public Safety Answering Point (PSAP) and will be accurate to within 125 meters in 67% of these cases."

The concept of referring to a 67% confidence level within 125 meters as parameters is good; however, problems with other parts of this language are twofold: (1) it does not specify what "within 125 meters" means. This statement seems ambiguous and needs clarifying perhaps by stating "accurate to within 125 meters with respect to the user's true position", and (2) it is unclear as to whether a single measurement distribution or multiple measurement distributions are implied. Multiple distributions will typically be realized in field measurement trials as the user's location is moved around in the deployment region. OTI recommends that specific language regarding the distribution of user true positions be included in the accuracy requirement to ensure objective characterization of system accuracy performance and to facilitate ready comparison of reported results among different vendors and/or operators.

D. ALI Accuracy Specification

Consider now use of the CEP as a metric in characterizing the confidence level associated with the measurement accuracy. OTI believes in associating confidence levels with any performance metric that characterizes ALI accuracy; the intent of the CEP criteria is to do just this. In this context, a CEP percentile of 67% with the accuracy event defined by a circle of radius r = 125 meters centered around the user's true latitude and longitude sufficiently characterizes the conditional ALI accuracy event needed in system performance validation tests. Such a statement is sufficient to constrain those parameters that are required in modeling the joint probability distribution of field trial error measurement data. Such a statement also allows vendors and operators the degree of freedom to model this distribution in such a way as to "best fit" the population of the true (underlying) error measurement distribution.

For example, it is noted that real world joint probability distributions characterizing the error measurements most likely do not possess circular symmetry. In this sense, the use of circular-symmetric probability distribution models to characterize the underlying statistics is not valid, although mathematically convenient. Assuming such distribution models, CEP analysis using circular symmetric probability distribution models will likely render false impressions regarding the delivered ALI accuracy.

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[3] Wireless E911 Implementation Ad Hoc ("WEIAD") recommendation to the FCC, November 25, 1998, CC Docket 94-102.

Perhaps there are several reasons why the distributions do not possess circular symmetry. First of all, the MLC latitude-longitude measurement points are correlated. This correlation is due to several things, viz., (1) geometry of the base station deployment, (2) the MLC algorithm, and (3) multi-path effects on TOA measurements, etc. Correlation properties need to be taken into consideration when modeling the error measurement probability distributions relative to its true behavior.

To improve the degree of fairness to the system developer, one could employ non-circular symmetric probability distribution models to characterize the measurement error distribution. To a first approximation, this would allow the accuracy metric to take into account Horizontal Dilution of Precision ("HDOP") effects which the current specified metric does not attempt to address. In this regard, OTI believes that a first step to more accurately modeling the error measurement data is to use the bi-variate, Gaussian probability density model with parameters characterized using the measurement data. This distribution does not possess circular symmetry and, to a first approximation, takes into account deployment geometries (hence, HDOP effects). This distribution also possesses elliptical symmetry in the sense that radial orientation and oblateness in the measurement data serves to allow for the characterization of measurement results where large probability masses exist in the error measurement data. Evaluation of the CEP for the measured joint probability distribution requires knowledge of where the user is located, the standard deviations of the latitude and longitude measurements, plus the degree of correlation that exists between the two measurements. The CEP of the modeled distribution can then be evaluated and compared with the recommended FCC specified CEP percentile. This serves to validate performance in that region; averaging over the distributions collected from all measured regions renders the ALI accuracy in that deployment area or areas. From the perspective of location system developers and operators, the CEP metric evaluated using this approach should model the measurement data with greater integrity.

E. Integrity and System Reliability Performance Validation Metrics

From a user safety perspective, OTI believes that integrity and reliability are also important system performance metrics that must be used when evaluating and validating location systems. PSAP's, operators, vendors, and the FCC should also be concerned with these issues. To date, integrity and system reliability[4] have not been considered to be a part of the process of evaluating/validating the system performance delivered to the end user.

Integrity can be defined as the ability of a system to detect and to indicate its malfunctions to ensure that the system is not being used when it is not operating within its specified accuracy performance limits. In other words, a location system having adequate integrity "will not lie" about being outside the CEP region. Instead, it will indicate when it is presenting erroneous data when it exists outside the envelope of the

[4] Availability is also a candidate here.

acceptable accuracy limit. In this sense, characteristics of system integrity are: the ability to detect a "bad measurement", the time delay associated with the detection of a "bad measurement", the time it takes to perform a new measurement, and the time to alert the PSAP via the MLC.

The system reliability requirement is based upon the need for a high probability of continuous functioning of an end-to-end location system in such a way that the user can roam about safely. A highly reliable location system is one that provides the user, acceptable service anywhere and anytime it is needed. In summary, OTI believes that the FCC mandate should include specification of system integrity and reliability.

CONCLUSION

The Commission should revise the current accuracy performance metric, namely 125 meters RMS, as contained in the Phase II wireless E911 rules Section 20.18(e). The Commission should establish a specific and unambiguous location accuracy requirement, namely:

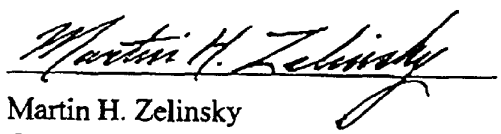
> "All Phase II E911 calls shall be located with accuracy defined by a circle of radius 125 meters with a Circular Error Probability ("CEP") greater than or equal to 0.67. This CEP will be an average of several conditional CEP's that are defined by circular regions of radius 125 meters centered upon the user's true position. The set of user true positions hypothesized is to be uniformly located throughout the deployment region to be defined."

Further, the Commission should incorporate integrity and reliability performance metrics for Phase II wireless E911 requirements consistent with the discussion set forth above.

OTI appreciates the Commission's ongoing efforts to promote the rapid implementation of wireless E911 Phase II capability by October 1, 2001. The timely resolution of the complex issues now before the Commission will best serve the public interest.

Respectfully submitted,

OMNIPOINT TECHNOLOGIES, INC.



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